DRSAR/SA/N-15

A LIMITED LOGISTICS EVALUATION OF THE MODIFICATION OF THE 155MM TOWED HOWITZER (M114A1) TO UTILIZE SECOND-GENERATION IMPROVED AMMUNITION

DONALD R. ECKMAN

FEBRUARY 1976

US ARMY ARMAMENT COMMAND
SYSTEMS ANALYSIS OFFICE
ROCK ISLAND, ILLINOIS 61201

DISPOSITION

Destroy this report when no longer needed. Do not return it to the originator.

DISCLAIMER

The findings in this report are not to be construed as an official Department of the Army position.

WARNING

Information and data contained in this document are based on input available at the time of preparation. Because the results may be subject to change, this document should not be construed to represent the official position of the Army Materiel Development and Readiness Command unless so stated.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DRSAR/SA/N-15	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A LIMITED LOGISTICS EVALUATION OF THE MODIFICATION OF THE 155mm TOWED HOWITZER (M114A1) TO UTILIZE SECOND-GENERATION IMPROVED AMMUNITION		5. TYPE OF REPORT & PERIOD COVERED Note - Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Donald R. Eckman		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Armament Command Systems Analysis Directorate (DRSAR-SA) Rock Island, IL 61201		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Command Systems Analysis Directorate (DRSAR-SA) Rock Island, IL 61201		12. REPORT DATE February 1976 13. NUMBER OF PAGES 34
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Second-generation improved ammunition
155mm towed howitzer, M114A1
Value analysis
Improved Conventional Munition (ICM)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

OBJECTIVE: To determine various strategies of modifying the M114A1 155mm Howitzer to a 1-turn-in-20 caliber rifling and to evaluate the relative cost, ammunition availability (current and improved) and production constraints. Also to consider the sensitivity of slippage of the XM198 milestone.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (Cont'd)

METHOD: A straight forward, expected value analysis within given constraints. Comparisons of effectiveness and costs were made in various policies.

RESULTS: The study indicates that the cost of any program undertaken is determined only by the number of weapons modified. Other costs and cost avoidance do not influence results within the scope of the problem. The approximate number of weapons that could be supported with anticipated ammunition supplies was determined.

SUMMARY

Because of uncertainties in the availability of a 155mm towed weapon system capable of firing second-generation ammunition in the time period of 1975 through 1980, the following problem was identified:

Determine various strategies of modifying the M114A1 155mm towed howitzer to a 1-turn-in-20 calibers (1/20) rifling and evaluate these strategies in relation to:

- Costs
- Ammunition availability (current and improved)
- Production constraints (modified M114A1 and the M198 155mm, towed howitzer) and also consider sensitivity of slippage of the M198 Initial Operational Capabilities (IOC) milestone.

The method utilized was straight forward, expected-value analysis within given constraints. An effectiveness measure, available weapon days (AWD), was defined as the objective variable in the problem. This variable is the result of the integration of the number of weapons supplied over the days available. Comparisons of effectiveness and costs were made for various policies.

The results of such a study indicate that the cost of any program undertaken is determined only by the number of weapons modified. Other costs and cost avoidance do not influence results within the scope of this problem. These results further indicate that approximately 126 to 162 weapons can be supported with expected supplies of ammunition. This is based upon mobilization conditions. The problem was constrained to include only US Army active and reserve forces, although effects on Marine Corps requirements were considered. Furthermore, only minimum production policies for ammunition and nominal production policies for the M114A1 retube program prior to mobilization were considered. The use of the modified M114A1 was limited to Northeast Asia (NEA) and the number of modifications were constrained by available supply of improved ammunition.

At this time the measurement of "military-worth" of the modified M114A1 with improved ammunition has not been determined.

Next page is blank.

TABLE OF CONTENTS

Next page is blank.

LIST OF FIGURES

LIST OF TABLES

DISCUSSION OF PROBLEM

BACKGROUND

In 1970 the Marine Corps, in anticipation of issue of the second-generation Improved Conventional Munition (ICM) ammunition, sought to determine the adaptability of the current 155mm towed howitzer (M114A1) for use with this ammunition. It was determined that one rotation in 20 calibers (1/20) of rifling, as used in the M109 155mm self-propelled howitzer, would allow use of the second-generation ICM in the current towed howitzer system. The current charge constraint--zone 7--would be maintained. Two M1A1 cannon blanks were rifled to this specification at Watervliet Arsenal and, subsequently, tested at Aberdeen Proving Ground. These tests verified the feasibility of using second-generation ICM in the M114A1 howitzer modified with the 1 rotation/20 caliber rifled cannon. Furthermore, these tests indicated that the M109 firing tables prepared for this ammunition would be adequate for the modified M114A1 system.

In October 1973, Systems Development Division-Guns (AMSAR-RDG) investigated the utilization by the Army of the modified M114A1 to use second-generation ICM. Inquiries were sent out to various Commands. In general, responses were negative to the suggestion of introducing the modified howitzer on an attrition or wear-out basis, considering the status of the second-generation ICM.

The inquiry was pursued and a fact sheet was prepared by AMCPM[1] which initiated an inquiry by the CG of the US Army Armament Command-"What are we doing about it?"[2] AMSAR-RDG then requested AMSAR-MM to conduct a study to determine"...., feasible and cost effective alternative...presented to user for acceptance."[4] AMSAR-AS was designated as the coordinating agency[3]. The cover letter further requested, in paragraph 4, as follows: "Accordingly, request your directorate conduct a study, with necessary coordination with other ARMCOM directorates, that examine and establishes the costs, timing*, and problems associated with each possible alternative. Sugest the study include consideration of present stock

---

[1]Fact sheet from AMCPM-SA2, Subject: 155mm M114 Towed Howitzer/New Projectiles, dtd 8 March 1974.

[2]Memo from Commanding General, dtd 15 March 1974.

[3]DF from AMSAR-RDG to AMSAR-CG, Subject: M483 Projectile Compatability with M114A1 Howitzer, dtd 8 April 1974.

[4]DF from AMSAR-RDG to AMSAR-MM, Subject: M483 Projectile Compatability with M114A1 Howitzer, dtd 8 April 1974.

*Author's underline.

of both cannon and M449 projectiles: conversion on some basis other than "one-time" or pure attrition, e.g., on a battery or battalion basis when the first cannon is required for any reason. Concurrent with release of the M483 projectile to an area, etc., availability of production capacity at Watervliet Arsenal; availability of raw materials (i.e., tube blanks); and proposed number of M114A1 howitzers to be converted considering projected fielding data of XM198 howitzer (should include sensitivity analysis of changes to that date)."

A request for the same study was forwarded to AMSAR-SA by AMSAR-RDG[5]. Response from AMSAR-SA for data was sent to AMSAR-RDG[6], indicating completion of study 30 days after receipt of data.

Initial information on IOC data of the various ammunitions and the XM198 howitzer was prepared by AMSAR-ASA[7] and forwarded to AMSAR-SA. An oral presentation of results was presented on June 14, 1974 by AMSAR-SAL to representatives of AMSAR-ASA and AMSAR-SA, (AMSAR-RDG did not attend because of conflicting commitments.) The results showed that cost was essentially independent of the strategy of introducing the modified howitzers. In addition, effects of ammunition production were presented. These results, modified by questions and guidance arising from the presentation, are the subject of this report.

SCOPE OF PROBLEM

The boundaries of the study were expressed in terms of artillery systems, ammunition used, operational units, and time.

Artillery Systems. The systems considered are restricted to 155mm towed artillery, currently in use or under development. Included in this definition are the existing primary and secondary 155mm howitzers, M114A1 and M114, respectively, and the XM198 155mm howitzer. The implication of this restriction is that the problem is peculiar to Northeast Asia. Towed artillery would be almost exclusively used in this theater. In contrast, the European scenarios would include only a few pieces of 155mm towed artillery.

The critical variables in regard to these systems are the dates of the Initial Operational Capability (IOC) and the production capabilities for modification and replacement.

---

[5] DF from AMSAR-RDG to AMSAR-SA, Subject: M483 Projectile Compatability with M114A1 Howitzer, dtd 16 April 1974.

[6] DF from AMSAR-SA to AMSAR-RDG, Subject: M483 Compatibility with M114A1 Howitzer, dtd 1 May 1974.

[7] DF from AMSAR-ASA to AMSAR-SA, Subject: Howitzer M115 M114A1, dtd 17 May 1974.

Ammunition. The question of the necessity for providing the "hi-twist" 155mm capability arose out of the requirement for high-rotational velocity of improved ammunition for stabilization. For this reason the problem is restricted to the use of the improved ammunition, specifically the M549 RAP and M483 DP projectiles. These are the only second-generation 155mm ICM rounds which have a current production potential. The M449 AP projectile is considered only because M483 DP will replace it. Other 155mm rounds, M107 HE, M107E1 HF, etc., are not considered to be factors in this problem because their use is independent of the delivery systems considered. The prime variable is the availability of the improved ammunition. This arises from the fact that the proposed modification would achieve no purpose unless there were sufficient ammunition available to make use of the modification. In order to determine the availability, the IOC dates, rate of production, and rate of use (day rate of fire) are necessary inputs. Due to the implication arising from restriction to towed artillery, the combat rates were taken from the NEA scenario.

Operational Units. The units considered as candidates for issue of the modified howitzer were limited to US forces. These were US Army active duty units, US Army reserve duty units, and National Guard units. The Marine Corps was excluded since it is currently engaged in procurement of this modification in an independent program.

Time. The time frame extended from the start of FY 1975 to 1980. During this period the need for the improved ammunition would become more urgent while the availability of the required weapon, XM198 155mm howitzer would be uncertain. In fact, during the early part of this period, there would be no way to utilize the improved ammunition in the Asian Theater.

ASSUMPTIONS

- Phase I of the NEA scenario provides the boundaries of the problem:
  1. Ammunition usage is limited to towed artillery.
  2. Ammunition combat rates for US forces in Korea are applicable.
- Logistics of ammunition and weapons would be synchronized;
  1. Fabrication of the hi-twist cannon would be coordinated with ammunition supply.
  2. Shipments of ammunition would be coordinated with shipments of hi-twist cannon.
- The replacement cost of the current M1A1 cannon used in the M114A1 howitzer and the production/installation cost of the hi-twist replacement are equal.

- The investment in production facilities for the modification of the M114A1 howitzer is negligible.

GUIDANCE

- Only US forces are to be considered.
- Marine Corps Orders would be given precedence for the hi-twist cannon (88 funded - 30 follow-on).
- Available ammunition stocks are prorated between the Army- and Marine Corps-based mobilization requirements. (PBA on revisions as of June 3, 1974).
- Basis of issue policy would be by battalion (18 weapons).

DATA

Table 1 lists the parameters and variables considered in the analysis along with the values and sources from which the data was obtained. In most cases the data was obtained in verbal conferences either by telephone or face-to-face discussion. In several instances the data was given by the interpreter and not the originator of the data; see remarks column in Table 1.

METHOD

General.

A measure of effectiveness was defined as available weapon-days (AWD) prior to issue of the XM198 155mm howitzer system. This measure combines the following:

1. The number of hi-twist cannons issued.
2. The time each weapon would be available.

This measure of effectiveness combined with the cost function provides the results of this analysis.

In order to put the problem in an operational perspective, a number of options were formulated. These options were based on the expected introduction of units into the NEA scenario and other factors at hand, such as requests for hi-twist capability by specific units.

The issue of the hi-twist cannon was considered in light of available ammunition supplies of the M549 and M483 projectiles. A separate analysis was made for each of these projectiles.

The following specific factors were considered as the primary problem parameters:

1. Slippage of the IOC for the XM198 howitzer.
2. Slippage of the IOC for the M549 and M483 projectiles.
3. Variation in IOC of the hi-twist M114A1 howitzer.

TABLE 1. DATA: VALUES AND SOURCES

PARAMETER/VARIABLE	SYMBOL	VALUE	SOURCE	REMARKS
Production Rate of M198 155mm Howitzer	P_{198}	20 units/mo.	AMCPM-CAWS	Verbal communication (Mr. John Manley)
Maximum Production Rate of M114A1 Howitzer Modification	P_h	50 units/mo.	Watervliet Arsenal	Verbal communication (Mr. M. Gilchrist)
Production Build-Up for M114A1 Howitzer Modification	- -	Build-Up Rate Linear from 0 to Max over 5 mo.	Watervliet Arsenal	Verbal communication (Mr. M. Gilchrist)
Cost of Mfg and Installation of "hi-twist" modification in M114A1 Howitzer	C_h	$30,000/unit	AMSAR-ASA	Verbal communication (Mr. S. Stryjewski) No cost break for quantity (Watervliet)
Capitalization for Production Equipment for "hi-twist" modification	K_h	nil	Watervliet Arsenal	Via AMSAR-ASA and AMSAR-RD (Stryjewski/Cox)
Cost of Replacement of Current M1A1 Cannon for the M114A1 Howitzer	C_{M141}	$30,000/unit	AMSAR-ASA	Verbal communication (Mr. S. Stryjewski)

TABLE 1. DATA: VALUES AND SOURCES - (Con't)

PARAMETER/VARIABLE	SYMBOL	VALUE	SOURCE	REMARKS
Life of 155mm Cannon (Towed Howitzer) at Anticipated Peace-time Usage	L	27-1/2 yrs	AMSAR-MM	Inferred from Memo for Record 22/Mar/74 (Mr. Mizeur), Reference 8
Issue Policy	b	18 Howitzer/ Bn	TRADOC	Verbal via AMSAR-ASA
Marine Corps Requirement for Modified M114A1 Howitzer	R_M	1st mo. 5 units 2nd mo. 23 " 3rd mo. 30 " 4th mo. 30 " 5th mo. 30 "	AMSAR-PP	1st 4 mos. funded, 5th mo. anticipated
Lead Time to Start of Production of Modified M114A1 Howitzer	IOC hi-twist	+18 mos. from start FY 75 nominal (+15, +21, & +24 mos.)[a]	Watervliet Arsenal	Verbal communication (Mr. M. Gilchrist)
Initial Operational Capability of XM198 155mm Gun System	IOC XM198	P 100% = +51 mos. P 50% = +45 mos. P 10% = +39 mos. after start of FY 75	AMSAR-CAWS	Verbal communication (Mr. John Manley) All three values parameterized

[8] Memorandum for Record from AMSAR-MM, Subject: Cannon 155mm M1A1 for Howitzer M114A1, dtd 22 March 1974.

[a] Other parameter variations

TABLE 1. DATA: VALUES AND SOURCES (Con't)

PARAMETER/VARIABLE	SYMBOL	VALUE	SOURCE	REMARKS
Restart of Production of M483 DP	IOC M483 or IOC Ammo	+12 mos. after start of FY 75 (nominal) (+18 & +24)[a]	AMSAR-ASA	DF, 17 May 74, subj: Howitzer 155mm M114A1 (S. Stryjewski) sgnd W.T. Green, LTC, GS
Start of Production of M549 RAP	IOC M549 or IOC Ammo	+6 mos. after start of FY 75 (nominal)[a]	AMSAR-ASA	DF, 17 May 74, subj: Howitzer 155mm M114A1 (S. Stryjewski) sgnd W. T. Green, LTC, GS
Proration of Production Army/ Marine Corps for M483-DP Proj and M549-RAP Proj	- -	Army/Marine - M483 - 86%/14% - M549 - 74%/26%	DCSLOG	Via AMSAR-PP (Mr. J. Pohlman) Army based on requirements as of 3 Jun 74 (FY 80) Marine Corps based on 28 Feb 74 requirements as modified
Usage Rates of M483-DP Proj and M549-RAP Proj	- -	M483-DP 10.02 Rnd/ Wpn/Day M549-RAP 1.71 Rnd/ Wpn/Day	CAA	Taken from P76-80 studies for US Forces in Korea (Combat Rate Studies)

[a] Other parameter variations

The problem was investigated independently over ranges of parameters as indicated in Table 2.

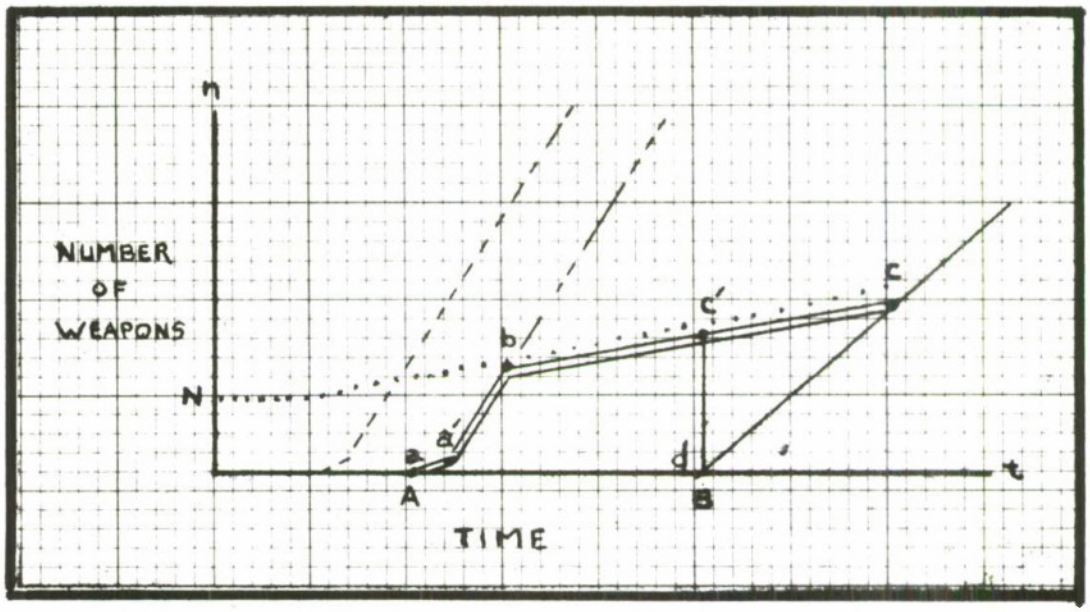
TABLE 2. PARAMETER VALUES USED

Parameter	Time from start of FY 75 (mos)
IOC date of M198 howitzer	39, 45, 51
IOC date of M483 projectile	12, 18, 24
IOC date of M549 projectile	0, 6, 12
IOC date of hi-twist cannon	15, 18, 21, 24

Effectiveness Model.

The model used in this analysis is a simple expected value, algebraic formulation. A graphic illustration is presented in Figure 1.

In this model, the effectiveness measured in available weapon days (AWD) is constrained by Marine Corps requirements (line a-a'), availability of the modified M114A1 howitzer (line a'-b), the availability of ammunition (line b-c or line b-c'), and the availability of the XM198 howitzer (line d-c). The integration within these limits yields the effectiveness (AWD). In general, the results presented are based on the polygon a-a'-b-c'-d-a rather than a-a'-b-c-d-a, although the latter was calculated. The former limits are based on termination of the M114A1 modification at the XM198 IOC. The latter case considers M114A1 modification to be always available.



LEGEND

----------	Maximum production of the hi-twist cannon
___ -- ___	Maximum introduction of the hi-twist cannon
_____	Introduction of the XM198 howitzer
.....	Ammunition Availability (in number of weapons supported)
═══════	Constrained introduction of the hi-twist cannon
A	IOC date of hi-twist cannon
B	IOC date of XM198 howitzer
n	Existing ammunition supply
Area (a,b,c,d)	Weapon days based on concurrent production of XM198 and hi-twist cannon
Area (a,b,c',d)	Weapon days based on stopping hi-twist cannon production at IOC date of XM198 howitzer.
a - a'	Represents constraint due to Marine Corps requirements

Figure 1. A Graphic Presentation of the Hi-Twist Cannon Replacement Weapon - Day Concept.

Cost Model

The cost combined with a measure of effectiveness provides the parameters of interest in this analysis. The cost was determined to include:

1. The value of cannon life lost. This is the value of the current M1A1 cannon lost when replaced by the hi-twist modification and the value of the hi-twist cannon lost when replaced by the XM198 howitzer. The case in which the current M114A1 howitzer is replaced by the XM198 howitzer is not evaluated since this loss will occur whether or not the hi-twist modification program is accepted. With reference to Figure 2:

The net life of current cannon* lost when replaced with hi-twist modification is

$$\left(IOC_{198} + \sum_{i=1}^{N/b} ib/P_{198}\right) - \left(IOC_{H} + \sum_{i=1}^{N/b} ib/P_{H} = L_{c}.\right) \quad (2)$$

The life of the hi-twist cannon* lost when replaced with XM198 gun system is

$$\left(IOC_{H} + L + \sum_{i=1}^{N/b} ib/P_{H}\right) - \left(IOC_{198} + \sum_{i=1}^{N/b} ib/P_{198} = L_{h}.\right) \quad (3)$$

Then, where V_H is the unit value of the production and installation of the hi-twist modification,

V_C is the unit replacement values of the current cannon average

and assuming that the life of current cannons will exceed the time to replace them with the hi-twist modification, the total value of cannon life lost is

$$V_T = V_H \times N \times \left[\frac{L_H}{L}\right] + V_C \times N \times \left[\frac{L_C}{L}\right] \quad (4)$$

i.e., the basic value of the hi-twist multiplied by the fraction of life remaining and the similar calculation for the current cannon.

*Based on expected firing rates from Ref. 8.

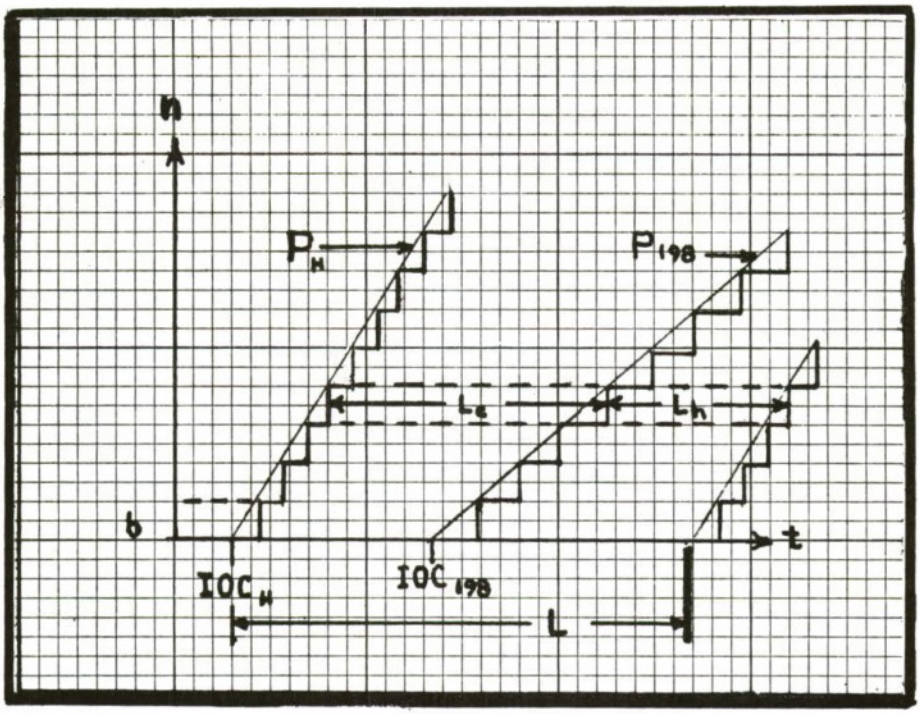
If $V = V_H = V_c$ as is assumed,

$$Vt = V \times N$$

since $L_c + L_H = L$

2. The cost of laying away facilities for the M449 projectile. If any facilities are maintained for the M449 projectile requirements for the current M114A1 howitzer, they would be eliminated if use of the M483 in the M114A1 howitzer were feasible. The magnitude of this cost elimination would be a function of the maintenance cost of the various facilities and the reduction in requirements resulting from conversion of the M114A1. The reduction in requirements would be in direct proportion to the fraction of M114A1 howitzers modified.

3. The cost avoidance. This area represents the savings attained by eliminating any requirement for the M449 projectile.



LEGEND

IOC_H	Initial operational capability of hi-twist modification
IOC198	Initial operational capability of XM198 howitzer
L_c	Cannon life lost - current cannon
L_h	Cannon life lost - hi-twist cannon
L	Expected cannon life
P_H	Production rate of hi-twist cannon
P_{198}	Production rate of XM198 howitzer
b	Issue factor - number of weapons replaced assumed the same for hi-twist and XM198
n	Number of units replaced
t	Months

Figure 2. Graphic Model of Cannon Life Lost

DISCUSSION OF RESULTS

OPTIONS CONSIDERED

The options considered are based upon the development schedules as defined in the PEMA Policy & Guidance[9]. The options are arranged in increasing weapon requirements (TO&E requirements for 155mm towed howitzer). These policies are specifically defined in Table 3 and cover the spectrum from initial commitment in NEA to total US Army Mobilization requirements.

COSTS

Cannon Life Lost.

It can be shown that the value of cannon life lost is dependent only upon the particular parameters of IOC dates of the XM198 howitzer, the M549 and M483 second generation ICM's, and the M114A1 howitzer (1/20) twist cannon modification. The strategy of issue does not affect the value of the life lost per modified cannon. Furthermore, when the cost of replacement of the current M1A1 cannon and the cost of manufacturing and installing modified cannon are equal, as is assumed here, the replacement cost is an adequate estimator of the unit value lost. Therefore, the program cost is dependent only upon the total number of modifications.

The rate of replacement given at 20 units per year based on 555 cannon[8] was converted into 27.5 year expected cannon life based on expected firing rates. This expected life exceeded any possible delay in introduction of the XM198 and allowed the fractionization of cannon life.

Maintenance of Facilities.

One cost factor that was considered was the maintenance of facilities for the M449 projectile. It was hypothesized that if all 155mm weapons could utilize the M483 projectile which would replace the M449, then this cost could be avoided. This issue has become moot since Congress has ordered all funding for facilities dedicated to the M449 to be stopped.

Regardless of the Congressional action, even policies that did not convert 100% of the M114A1 howitzers would have little effect on the

---

[8] Loc. Cit.

[9] PEMA Policy and Guidance for Preparation of Part 1 of the AMP (U), 31 January 1973 and Change 1, 18 June 1973. (SECRET)

maintenance cost for M449 facilities. Table 4 shows the status of facilities that were allocated to the M449 projectile in the Production Base Analysis (PBA) of 31 December 1973. It can be observed that the majority of facilities are of the M-day status, i.e., no funds are expended to maintain them since they do not exist. The following illustrates the magnitude of reduction in required facilities to initiate a reduction in the real cost of maintaining the facilities:

- For Load, Assemble, and Pack (LAP) facilities - 68%
- For Metal Parts (MPTS) facilities - 100%
- For Component facilities - 87%

This is based on the inverse ordering of the facilities as they appear in the PBA.

TABLE 3. OPTIONS CONSIDERED FOR INTRODUCING

THE "HI-TWIST" CANNON (MODIFIED M114A1 HOWITZER)

OPTION	NO. OF WEAPONS	DESCRIPTION
A	36	Active Units in Pacific Area
B	54	XVIII ABN Corp
C	72	Option A + Strategic Reserve Active Unit
D	90	Option A and Option B combination
E	90	All ABN-Corp and Div Atry
F	126	Combination of Options B and C
G	162	All Active Duty Units
H	216	Option G + 20% Reserve
I	270	Option G + 40% Reserve
J	324	Option G + 60% Reserve
K	378	Option G + 80% Reserve
L	432	Option G + All Reserve
M	558	All US Army Units

TABLE 4. FACILITIES ALLOCATED FOR M449 PRODUCTION

FACILITY	OPERATION			REMARKS[a]
	LAP	MPTS	COMP #2	
Louisiana Line G	36,000 (.048)			1,2
Louisiana Line Y		12,000 (.016)		
Louisiana Line M			1,388,000 (.029)	
Ravenna Line 5	100,000 (.133)			3
Ravenna Line 8	100,000 (.133)			3
Ravenna Line 7	100,000 (.133)			3
Honeywell Corp			800,000 (.019)	4,7
Amron Corp			2,000,000 (.041)	5,8
AVCO Corp			1,800,000 (.037)	4,9
Aerojet Corp			1,350,000 (.029)	6,10
M-Day	413,500 (.552)	737,500 (.984)	41,307,000 (.849)	
TOTAL	749,500 (.999)	749,500 (1.000)	48,645,000 (1.004)	

[a]
1 Shared with M404
2 Capacity after Expansion
3 Requires Conversion
4 Shared with CC #11 (M483)
5 Shared with CC #7
6 Planned Conversion CC #11
7 Requires $2,500,000
8 Requires $4,500,000
9 Requires $1,600,000 and +9 mos.
10 Requires $3,200,000 and M+9 mos.

Figure 3 shows that a reduction of facilities greater than 68% is required to effect any reduction in the base facilities layaway cost and that a 98% reduction in facility will only reduce facility costs by approximately 1%.

Because the issue is considered moot and the contribution of this cost would only be significant for M114A1 modification policies in excess of those considered, this cost factor was not considered in this analysis.

Cost Avoidance.

The complete replacement of the M449 by the M483 projectile would eliminate the need of opening the M449 facilities. The decision on the M449 has also rendered this argument moot. In addition, the opening of such facilities would occur after D-day (or M-day). Since there is no commitment for these funds, there is no cost avoidance--any costs would be transferred to the M483.

EFFECTIVENESS

The measure of effectiveness used in this study, Available Weapon Days, is constrained by:

1. The rate at which modifications to the M114A1 howitzer takes place.

2. The delay in the IOC of the modified M114A1 howitzer.

3. The slippage in the IOC date of the XM198 howitzer.

4. The slippage in the IOC date of improved ammunition (M483 DP and M549 RA).

In the absence of the ammunition constraint, the effectiveness is dependent only upon the difference between the IOC of the XM198 howitzer and the modified M114A1 and specified rates of production. Figure 4 is a presentation of Available Weapon Days as a function of number of weapons modified for various differences in the IOC dates of the XM198 system and the modified M114A1. As is expected, the effectiveness (AWD) increases with the number of modifications made. Because of the divergence in the production rates of the modified cannon and the XM198, the rate of increase of effectiveness (AWD) increases with the number of modifications made.

When the effects of production scheduling of improved ammunition are considered, one should expect added constraints and a reduction in effectiveness (AWD). However, this is not the case for the M549 RAP projectile. Due to the range of the IOC dates considered for

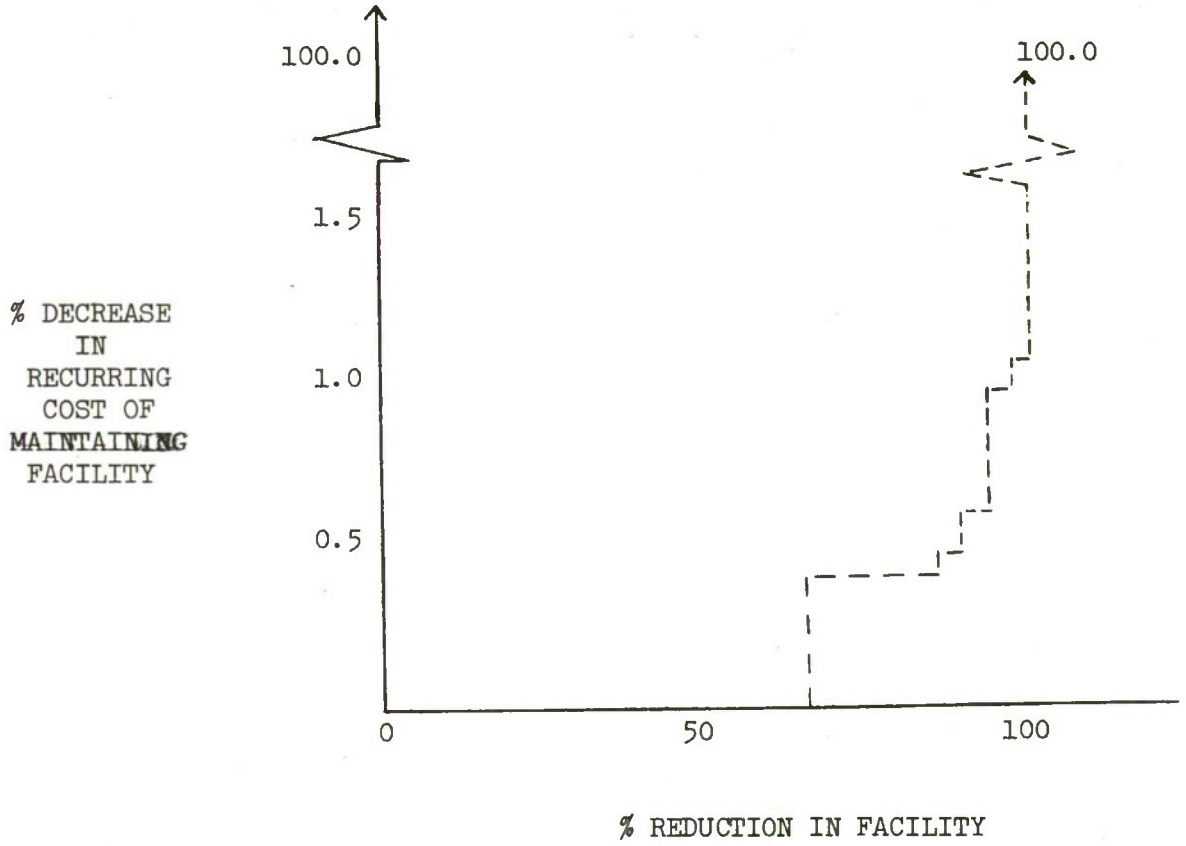


Figure 3. Reduction in Cost of Maintaining M449 Facilities As a Function of Reduction of Facilities

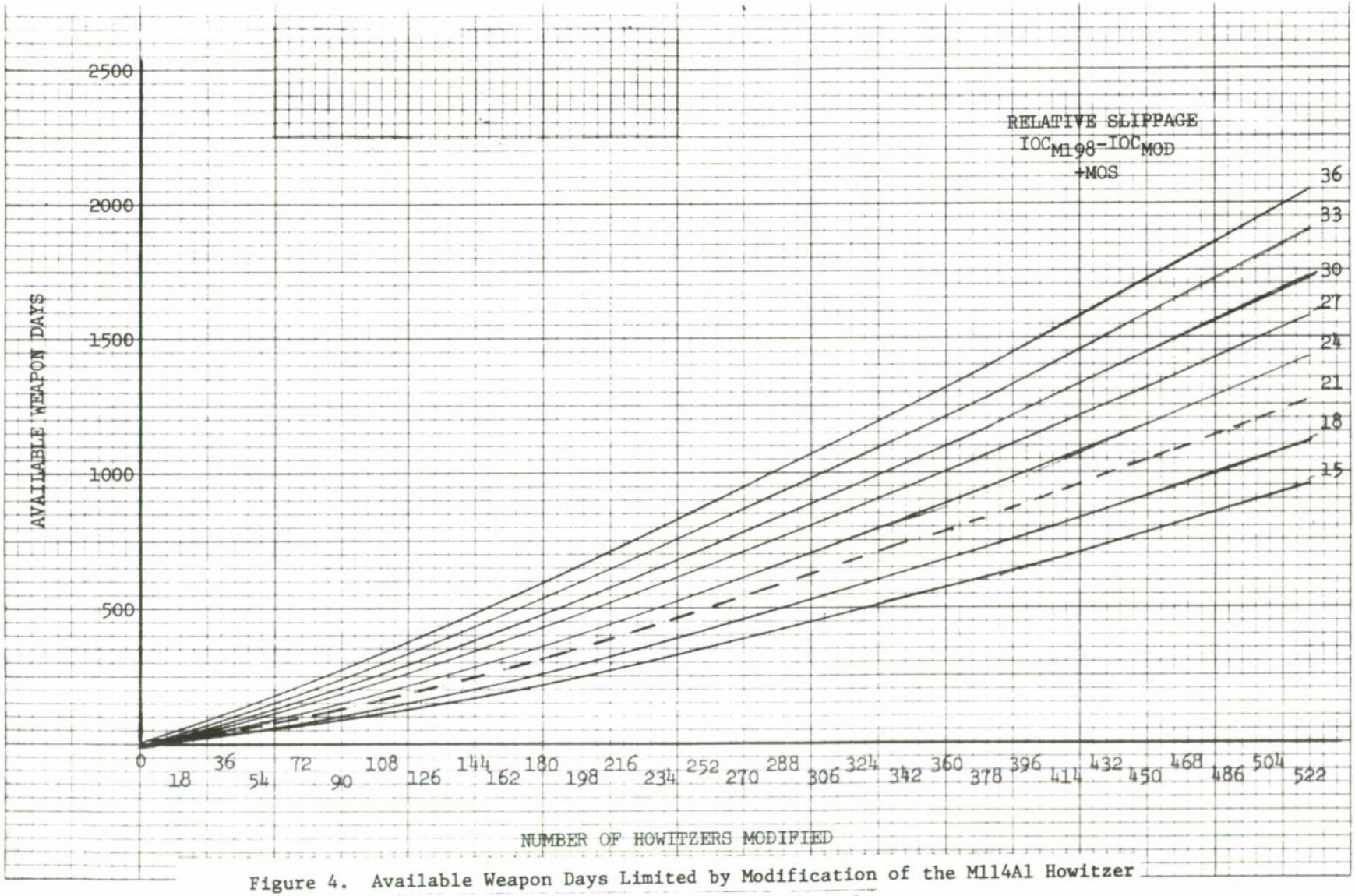


Figure 4. Available Weapon Days Limited by Modification of the M114A1 Howitzer or Introduction of the M549 RAP Projectile.

this round, the rate of production*, and the expected combat rate consumption, the availability of this round is kept at a sufficiently high level. Therefore, this constraint is less than the constraints imposed by the introduction rate of the modified cannon. The results shown in Figure 4 can be applied to the M549 case as well as to the non-ammunition constraint case.

However, when the M483 DP projectile is considered, there are significant effects on AWD. Figure 5 shows these effects for various IOC dates of the M198 and for a IOC date of the M483 round of +12 months. There appears to be little or no effect for less than 126 to 162 modifications.

This is further illustrated in Figure 6. Here, the relative effectiveness (the ratio of AWD to the number of weapons modified) is plotted vs. the number of weapons modified. The drop in relative effectiveness occurs after the number of weapons identified in options F and G (Table 3) have been surpassed.

RECOMMENDATIONS

With the uncertainty of the combat rates and production rates for second-generation ICM, only policies requiring modification of the number of weapons stated in option G (all active duty Army Units) or less should be considered. For option requiring modification of greater number of weapons, there is no pay-off in increasing the number of AWD.

*Eight thousand/month is total production which is prorated at 74% Army and 26% to the Marines.

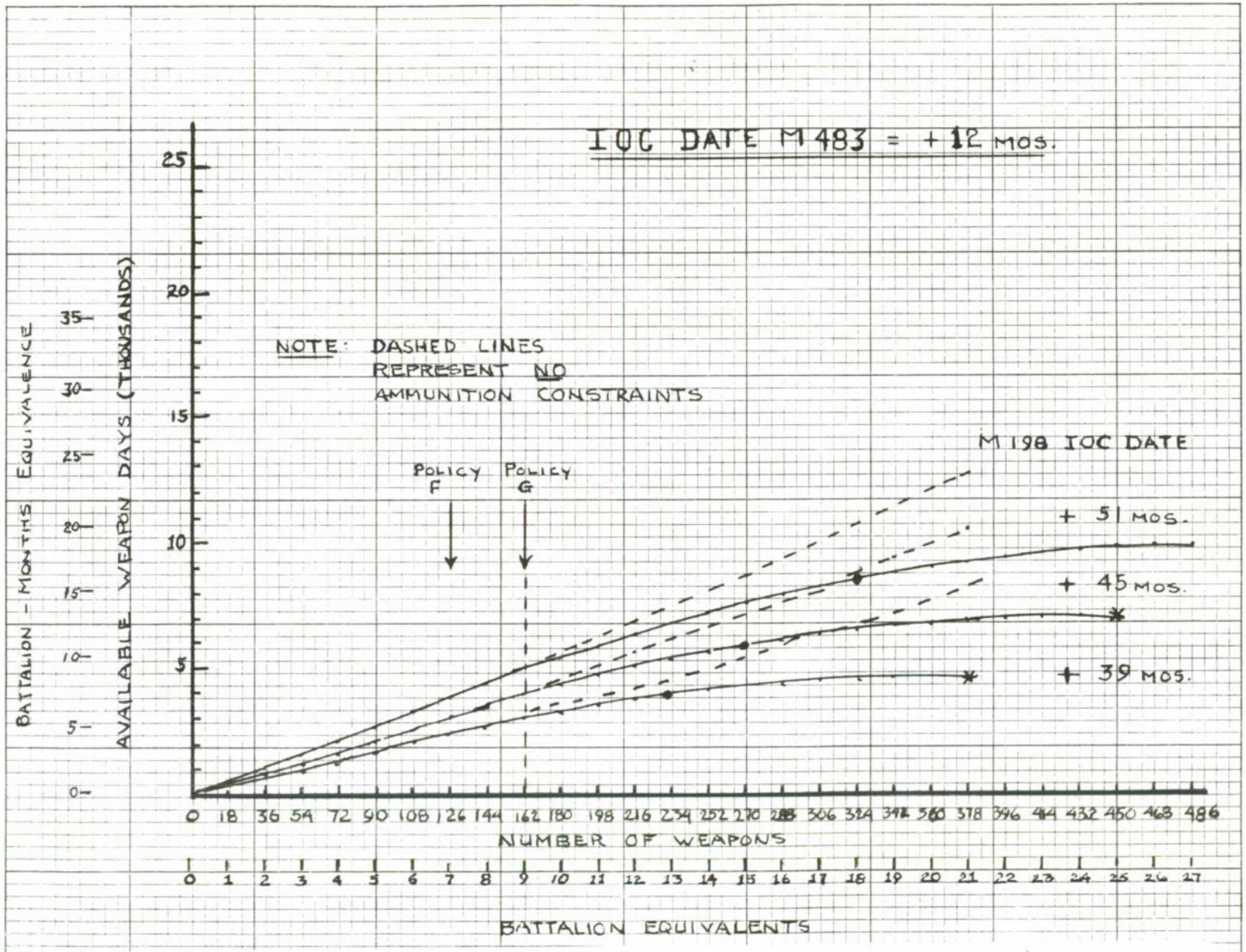


Figure 5. Effectiveness of the Hi-Twist Modification Constrained by Availability of the M483 DP Projectile

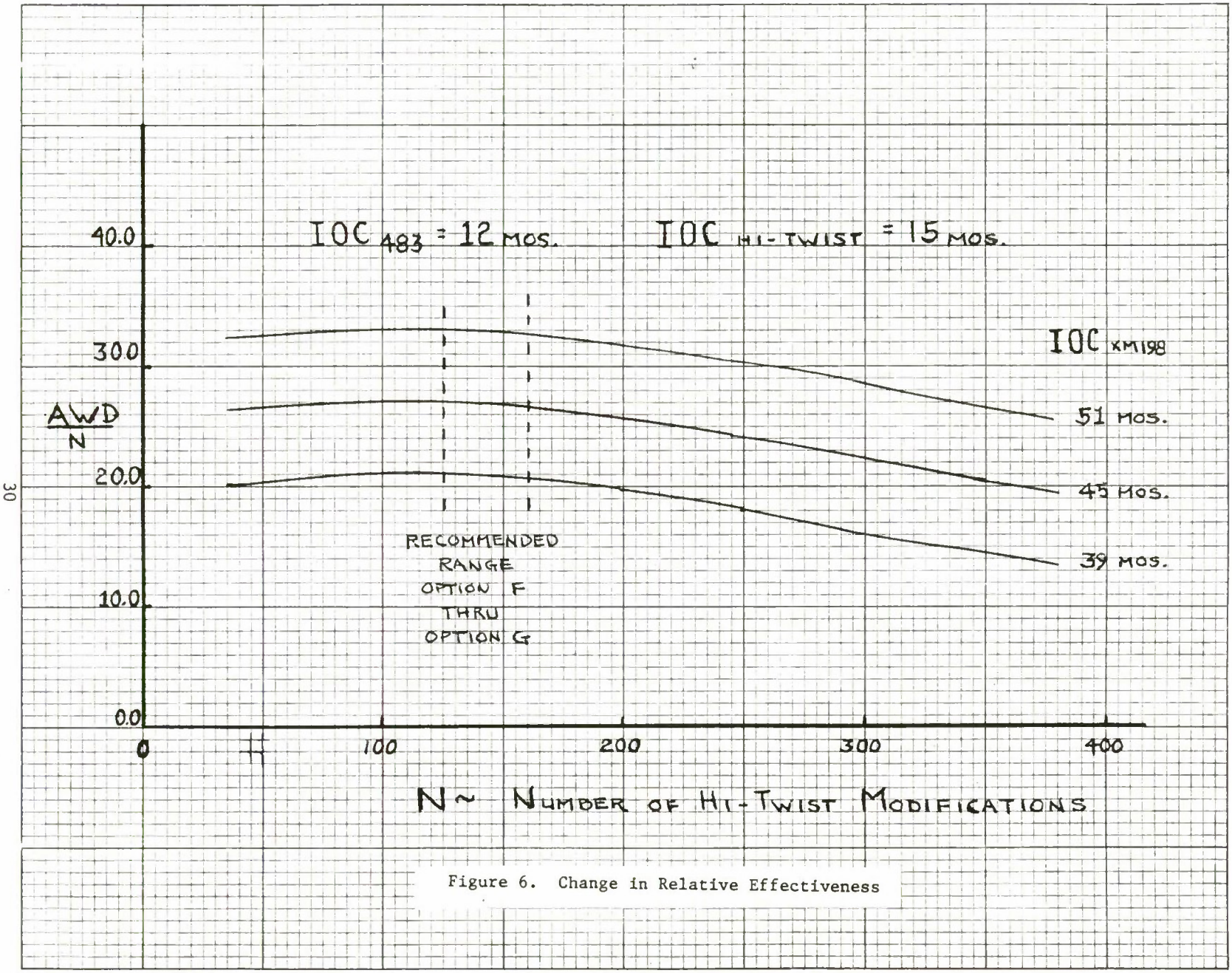


Figure 6. Change in Relative Effectiveness

REFERENCES

1. Fact Sheet from AMCPM-SA2, Subject: 155mm M114 Towed Howitzer/New Projectiles, dated 8 March 1974.

2. Memo from Commanding General, dtd 15 March 1974.

3. DF from AMSAR-RDG to AMSAR-CG, Subject: M483 Projectile Compatability with M114A1 Howitzer, dtd 8 April 1974.

4. DF from AMSAR-RDG to AMSAR-MM, Subject: M483 Projectile Compatability with M114A1 Howitzer, dtd 8 April 1974.

5. DF from AMSAR-RDG to AMSAR-SA, Subject: M483 Compatability with M114A1 Howitzer, dtd 16 April 1974.

6. DF from AMSAR-SA to AMSAR-RDG, Subject: M483 Compatability with M114A1 Howitzer, dtd 1 May 1974.

7. DF from AMSAR-ASA to AMSAR-SA, Subject: Howitzer M115 M114A1, dtd 17 May 1974.

8. Memorandum for Record from AMSAR-MM, Subject: Cannon 155mm M1A1 for Howitzer M114A1, dtd 22 March 1974.

9. PEMA Policy and Guidance for Preparation of Part I of the AMP (U), 31 January 1973 and Change 1, 18 June 1973. (SECRET)

Next page is blank.

GLOSSARY OF ABBREVIATIONS

AP	Anti-Personnel
AWD	Available Weapon Days
DP	Dual Purpose
FYDP	Five Year Defense Plan
HE	High Explosive
HF	High Fragmentation
ICM	Improved Conventional Munition
IOC	Initial Operational Capability
LAP	Load, Assemble, and Pack
MPTS	Metal Parts
NEA	Northeast Asia
PBA	Production Base Analysis
RAP	Rocket Assisted Projectile
TO&E	Table of Organization and Equipment

DISTRIBUTION LIST

No. of Copies	
5 2	Commander US Army Armament Command ATTN: DRSAR-SAL DRSAR-SAS Rock Island, IL 61201
1	Commander Rock Island Arsenal ATTN: SARRI-LPL Rock Island, IL 61201
12	Defense Documentation Center Cameron Station Alexandria, VA 22314